

Potential Designated Chemical

Manganese (Mn)

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Reasons for consideration

- ▶ Suggested in surveys of state scientists & the public
- ▶ SGP interest
- ▶ Laboratory capacity developed on a trial basis during pilot project

Criteria for designated chemical

- ▶ ***Exposure or potential exposure*** to the public or specific subgroups
- ▶ ***Known or suspected health effects*** resulting from some level of exposure based on peer-reviewed scientific studies
- ▶ ***Need to assess efficacy of public health actions*** to reduce exposure to a chemical
- ▶ ***Availability of a biomonitoring analytical method*** with adequate accuracy, precision, sensitivity, specificity, and speed
- ▶ ***Availability of adequate biospecimen samples***
- ▶ ***Incremental analytical cost*** to perform the biomonitoring analysis for the chemical

Manganese identity & uses

- ▶ Element and essential nutrient
- ▶ Uses:
 - Industrial applications, such as metal alloys, manufacture of batteries
 - Fungicides containing manganese
 - Additive previously used in gasoline (MMT)

Manganese exposure

- ▶ General population exposure primarily via diet
- ▶ Environmental exposures via drinking water and air can be significant
- ▶ Worker exposure primarily via inhalation

California sources of manganese

▶ Drinking water

- Exceedances of notification level (0.5 ppm) found in 42 of 58 California counties from 2001–2004
- Average of reported exceedances ~1 ppm (0.5 to 35 ppm; data includes inactive wells)

▶ Air

- Statewide ambient level: 24 ng/m³
- Two sites in MATES III study: 48 and 62 ng/m³
- Workplace example: 0.11 to 0.46 mg/m³

▶ Pesticide use

- Maneb: ~800K lbs; lettuce, nuts & other
- Mancozeb: ~300K lbs; grapes, onions, tree fruits & other

Known or suspected health effects

- ▶ Neurotoxicant in adults
 - Manganism syndrome
 - Motor and neurobehavioral effects
 - Parkinson's disease
- ▶ Developmental neurotoxicant
 - Effects on IQ, neurobehavior
- ▶ Association with birthweight
- ▶ Lung inflammation

Manganese pharmacokinetics

- ▶ Homeostasis generally maintained in adults exposed to normal dietary levels
- ▶ Excessive exposures have occurred via inhalation
 - Can be transported directly to brain via olfactory nerves
- ▶ Neonates may be vulnerable to excessive exposure
 - Less well developed biliary excretion
 - Immature blood–brain barrier
- ▶ Iron deficiency results in greater manganese absorption

Manganese biomonitoring studies

- ▶ Numerous studies identified in various populations
 - General population
 - Pregnant women/cord blood
 - Infants and children
 - Workers

Biomonitoring studies (cont.)

- ▶ Motivations for studies include:
 - Establishing reference ranges
 - Studying effect of MMT use
 - Studying worker exposures
 - Investigating links between blood, urine, hair or teeth levels and health effects

Examples of Mn biomonitoring results: General population

Location	Blood µg/L	Urine µg/L	Study
Canada	9.22	0.08	Health Canada 2010
Quebec	7.14		Baldwin et al. 1999
Germany, adults children	8.6	0.063 0.074	Heitland & Koster 2006a,b
Japan, women	13.2	0.14	Ikeda et al. 2010 Ohashi et al. 2006
U.S., NHANES Maine, children	30	0.53	Paschal et al. 1998 Rice et al. 2010

Values are geometric means

Examples of Mn biomonitoring results: Pregnant women/cord blood

Location	Pregnant women blood (µg/L)	Cord blood (µg/L)	Study
Oklahoma	24	42	Zota et al., 2009
Montreal	23	45	Smargiassi et al., 2002
Quebec	16.3 15.6*	34.3 32.3 *	Takser et al., 2004
Paris	23 20.4*	42 38.5*	Smargiassi et al., 2002 Takser et al., 2003

* Denotes geometric mean;
other values are arithmetic means

Laboratory methods

- ▶ Manganese has been measured in blood, urine, hair, saliva, teeth and nail clippings
- ▶ Some difficulties in linking levels in biological media to manganese exposure
- ▶ Cowan et al. found blood Mn–Fe ratio more sensitive measure of exposure

Laboratory methods (cont.)

- ▶ CDPH Environmental Health Lab (EHL) measuring manganese in whole blood on trial basis
- ▶ Analysis can be bundled with other metals
- ▶ Method in urine under development by EHL

Need to assess efficacy of public health actions

- ▶ Manganese is an essential nutrient, but also a neurotoxicant
- ▶ Study potential for excessive exposures
- ▶ Study exposures particular to California
- ▶ Biomonitoring would help:
 - Assess extent and level of exposure in California
 - Evaluate the need for further action